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Electric and thermoelectric properties of specular hematite

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In some recent communications the results of measurements of magnetic properties (Mukerjee 1967 a, b) of single crystals of naturally occurring hematite of purities 95.5% and 99.1% and the electric and thermoelectric properties of the former variety (Mukerjee 1968) were reported. The principal electrical conductivities ($\sigma_{\parallel}$ and $\sigma_{\perp}$) and Seebeck voltages ($\theta_{\parallel}$ and $\theta_{\perp}$ with respect to Pt.) of the latter variety have been recently studied in air in the temperature range 200°K to 1000°K for the fresh sample as also repeated for the same in this whole temperature range (figures 1 and 2). Due to heat treatment no permanent change* was produced and the results were reproduceable.

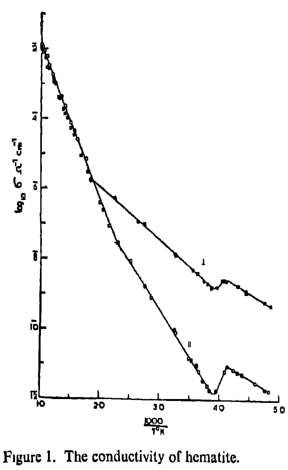

Figure 1. The conductivity of hematite. Open and solid points indicate measurements on fresh and heated samples respectively.

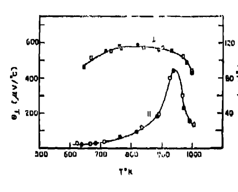

Figure 2. Seebeck effect of hematite. Open and solid points indicate measurements on fresh and heated samples respectively.

The temperature variation of principal conductivities could be given by a formula of the type

$$\sigma = \sigma_0 \exp \frac{-\triangle E}{kT}$$

where the symbols have their usual meaning (Smith 1959), but with different sets of values for σ_0 and $\triangle E$ for different temperature ranges which are given in table 1 for different crystallographic directions.

The changes in conductivities in both the directions round about 250°K are quite marked (figure 1) The magnetic properties of these samples were also found to undergo sharp changes near this temperature (Mukerjee 1967b). Neutron diffraction also shows a spin flip about this temperature (Shull *et al* 1951). It is further observed from figure 1 that anisotropy in electrical conductivity practically vanishes at high temperature. Due to very high resistances of the samples the Seebeck voltages could be measured only at high temperatures (figure 2). The signs of both the principal Seebeck voltages were found to be negative indicating that the electrons are the major charge carriers. Unlike the electrical conductivities, appreciable anisotropy in Seebeck voltages remains throughout the entire temperature region. Details of the work will be published soon elsewhere.

TABLE 1. $\triangle E$ AND σ_0 IN DIFFERENT TEMPERATURE REGIONS

Crystal direction	$\triangle E$ in ev	$\sigma_0 \Omega^{-1} cm^{-1}$	Temperature region °K
Basal plane	.20	5.0×10^{-5}	$T<240$
	.30	1.1×10^{-3}	$255<T<540$
	1.00	5.6×10^{2}	$540<T$
c-axis	.20	2.0×10^{-7}	$T<240$
	.55	6.3×10^{-3}	$255<T<385$
	1.00	5.6×10^{3}	$385<T$

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